# 3.0 WASTE INVENTORY

## 3.1 Maximum Extent of Operations

Consistent with guidance contained in Office of Solid Waste and Emergency Repsonse Policy Directive #9476.00-5 regarding RCRA closure and post-closure care standards, the maximum extent of operations for the CPP-601 WG/WH Storage and Treatment Tanks, the CPP-640 Headend Process Storage Tanks, and all associated equipment is assumed to be equivalent to the design capacity of the tank system. For the WG/WH tanks, the maximum extent of operations would be the design capacity of 18,500 gallons (4,500 gallons for each of four tanks). For the Headend Process Storage Tanks, the maximum extent of operations would be the design capacity of 1,500 gallons (500 gallons for each of three tanks).

## 3.2 System Throughput

### 3.2.1 Process Waste

Because of the change in mission for the INTEC, the fuel reprocessing activities are idle. Relatively small amounts of waste solutions are still generated from laboratories in CPP-602 and CPP-684. Currently, a nitric acid solution is added to the WG/WH collection tanks for criticality control. Approximately 4,500 gallons per month of acidic waste solutions are collected in the deep tanks before being sent to the PEW evaporator system in CPP-604.

During fuel reprocessing activities, PEW and raffinate solutions were being generated at approximately 13,500 gallons per 24 hour period. These solutions were acidic and contained different types of metals, depending on the type of fuel being reprocessed. This generation rate was consistent for the duration of the fuel reprocessing campaign, which could take up to six months for First Cycle reprocessing alone.

### 3.2.2 Decontamination Waste

Stainless steel functions by producing a hard, chemically resistant surface layer of mixed iron and chromium oxides. This layer contains microcracks that allow small amounts of solution to penetrate and form deposits containing radionuclides and other wastes. Rinsing the surface with water or acid cleans the surface, but cannot remove material trapped in the oxide layer.

The processes used to clean beneath the surface are collectively known as chemical decontamination. The chemicals used for decontamination are often hazardous themselves, and result in mixed hazardous waste generation. Disruption of the mixed oxide layer releases enough chromium to cause toxicity characteristic, even from contamination-free pipe. Decontamination chemicals are also high in sodium and potassium, which are difficult to calcine. A typical decon cycle consists of a strong caustic solution to break down the resistant oxide layer, followed by corrosive and/or chelating agents to remove exposed base metal and contaminants. The cycle is completed with a 6-M nitric acid flush to restore the oxide layer. Sampling the flushes for radioisotopes follows the progress of chemical decontamination. (Radioisotopes are tracked because they are much easier to detect – most chemical waste constituents would be below detection limits.) When the amount of radioisotopes being removed drops off, another cycle is begun using a different mix of chemicals. This process can

take months, continuing until the activity of the process lines and vessels is sufficiently reduced for personnel access. It is always necessary to balance the amount of waste generated against the anticipated radiation exposure for maintenance workers.

Decontamination processes following fuel reprocessing campaigns generated thousands of gallons of waste. A report published in March 1996 states decontamination activities from 1982 through 1990 at the INTEC First Cycle operation generated nearly 270,000 gallons of unprocessed liquid waste. This report is entitled Characterization of Nuclear Decontamination Solutions at the Idaho Chemical Processing Plant from 1982 to 1990, INEL-96/0014, March 1996. This report contains information describing the different fuel reprocessing campaigns, types and amounts of decontamination solutions used, and efficacy of the decontamination solutions. Table 3-1 shows the different types of decontamination solutions used from 1982 to 1990. Table 3-2 shows the typical chemical concentrations comprising the various commercial products used in decontamination. Table 3-3 shows chemical usage (without water) from 1982 to 1990.

## 3.3 Residual Waste

Few types of industrial equipment are designed to remove every last drop of their contents – even vertical walls can retain a thin film of liquid. During processing operations, uranium accountability measurements were very important, and were subject to similar problems of definition. The subject of residual holdup in an 'empty' tank was studied quite extensively. Most process tanks were designed to allow the liquid transfer equipment to drain the tank contents below the level detectable by instrumentation. The volume of liquid retained in the tank when the instrument reading just drops to zero is known as the 'instrument heel'. The volume of liquid retained in the tank when the transfer equipment is allowed to empty the tank as far as possible is known as the 'jet heel'. A study of jet heels in two of the primary accountability vessels was conducted using isotopic dilution. The result for VES-G-105, -155 showed a jet heel of 1.2 L (0.32 gal) for tanks with a working volume of 800 gal. This represents 0.04% of the liquid normally contained in the tank, as close to zero as reasonably achievable. Since these tanks have jets mounted on top of the tank, they provide an upper bound for vessels with jets or pumps that operate through bottom drains. This data, with adjustments for process knowledge of the geometry of various process vessels, was used for the volume of solution left in the process after flushing and draining.

The amount of residual waste in the interim status systems before closure activities are conducted includes liquid waste heels left in the tanks after they are emptied (active system), and any dried residue contained in the inactive portions of the system. There are approximately 25 liters (6.6 gal.) of liquid in a WG/WH tank after it has been emptied, due to the outlet pipe position. For the WG/WH tanks, this amount represents 0.2% of the total capacity of each tank. For the Headend Process Storage tanks, there are about 3 to 14 liters (0.8 – 3.7 gal.) of liquid left in a tank after it has been emptied. This amount represents 0.2 - 0.7% of the total capacity of each tank. With seven tanks, the amount of liquid left when the tanks are empty is approximately 142 liters (37.5 gal).

Amounts of residual solution in process vessels have been estimated and compared to the working volume of the process vessels in Table 3-4. This residual volume is estimated at 61 gallons, approximately 0.3% of the working volume. Sumps and abandoned vessels contribute another 19 gallons.

**Table 3-1**
**Decontamination Solutions Used From 1982 to 1990**

| Solution | kg | L | Flushes |
|---|---|---|---|
| $H_2O$ | 250,383 | 250,383 | 169 |
| $HNO_3$ | 68,343 | 241,995 | 164 |
| Turco 4502 | 8.965 | 114,628 | 55 |
| Tartaric/NaOH | 9,692 | 102,504 | 71 |
| $KmnO_4/HNO_3$ | 7,100 | 53,741 | 35 |
| Turco 4521 | 4,280 | 49,961 | 39 |
| Oxalic/$HNO_3$ | 4,388 | 71,067 | 31 |
| Oxalic Acid | 3,024 | 35,931 | 12 |
| $HF/HNO_3$ | 1,837 | 14,820 | 4 |
| Citrox | 1,362 | 21,819 | 15 |
| EDTA/NaOH | 1,202 | 18,757 | 20 |
| Turco 4324 | 491 | 22,486 | 10 |
| Turco ARR | 428 | 10,394 | 5 |
| Citric Acid | 279 | 3,000 | 3 |
| $NH_4OH$ | 49 | 2,900 | 1 |
| *Total* | *358,802* | *1,014,386* | *634* |

**Table 3-2**
**Typical Chemical Concentrations in Decontamination Solutions**

| Ref. No. | | | |
|---|---|---|---|
| 1. | | | Water |
| 2. | 2-6 | M | Nitric acid |
| 3. | 0.05 | M | Potassium permanganate in 2.0 M nitric acid |
| 4. | 30-60 | g/L | Turco 4521[a] |
| 5. | 60-160 | g/L | Turco 4502[b] |
| 6. | 0.3 | M | Oxalic acid in 0.2 M citric acid (Citrox) |
| 7. | 1.5 | M | Sodium hydroxide in 0.15 M tartaric acid |
| 8. | 7-30 | g/L | Turco 4324[c] |
| 9. | 1.0 | M | Oxalic acid |
| 10. | 0.5 | M | Citric acid |
| 11. | 0.5 | M | Oxalic acid in 0.5 M nitric acid |
| 12. | 0.5 | M | Ammonium hydroxide |
| 13. | 1.0 | M | Sodium hydroxide in 0.5 g/L EDTA (0.0017 M) |
| 14. | 60-360 | g/L | Turco ARR[d] |
| 15. | 0.5 | M | Hydrofluoric acid in 2.0 M nitric acid |

1. Turco 4521 is a commercial product composed of

| | |
|---|---|
| ammonium oxalate | 80 wt.% |
| oxalic acid | 15 wt.% |
| amorphous silica | <5 wt.% |
| citric acid | small amounts |
| 2-mercaptobenzothiazole | small amounts |

It is used as a reducing agent following 4502

**Table 3-2**
**Typical Chemical Concentrations in Decontamination Solutions (con't)**

2. Turco 4502 is a commercial product composed of

| | |
|---|---|
| potassium hydroxide | 70 wt.% |
| potassium permanganate | 20 wt.% |
| potassium chromate | <5 wt.% |
| Hexavalent chromium (as Cr) | is about 0.8 wt.% |

This is a strong oxidizing solution.

3. Turco 4324 is a commercial detergent composed of

| | |
|---|---|
| ammonium bicarbonate | 50 wt.% |
| sodium hexametaphosphate | 45 wt.% (approximately) |
| octylphenoxypoly (ethyleneoxy)ethanol | <5 wt.% |
| noctylphenoxpoly (ethyleneoxy)ethanol | <5 wt.% |
| sodium carboxymethyl cellulose | small amounts |

It is used to clean organics

4. Turco Alkaline Rust Remover (ARR) is a commercial product used for descaling. It is strongly caustic and is composed of

| | |
|---|---|
| sodium hydroxide | 70 wt.% |
| kerosine | <5 wt.% |
| triethanolamine | 15 wt.% |
| diethanolamine | <5 wt.% |

sodium gluconate may be present in small amounts

5. The solutions were heated either with vessels heating jackets or by steam sparging. Since air or steam jets were used in transferring solutions, the temperature was restricted to be below 55° C.

**Table 3-3**
**Decontamination Chemical Usage From 1982 to 1990**

| *Chemical Without Water* | *kg* |
|---|---|
| Nitric acid | 78,541 |
| Sodium hydroxide | 8,470 |
| Oxalic acid | 6,716 |
| Potassium hydroxide | 6,275 |
| Potassium | 5,384 |
| Sodium | 5,206 |
| Ammonium oxalate | 3,424 |
| Ammonium hydroxide | 3,423 |
| Potassium permanganate | 2,338 |
| Tartaric acid | 2,193 |
| Citric acid | 1,268 |
| Potassium chromate | 448 |
| Ammonium bicarbonate | 246 |
| EDTA | 231 |
| Sodium hexametaphosphate | 221 |
| Hydrofluoric acid | 100 |
| Hexavalent chrome as Cr | 72 |

**Table 3-4**
**Vessel Volumes and Residuals**

| Idle Process Vessels | Working (overflow) | Residual<br>F = Sampled Flush<br>A = Active | |
|---|---|---|---|
| VES-C-101 VCO | 580 L (700) | 3 L | F |
| VES-C-102 VCO | 0 L | 0 | F |
| VES-C-103 | 0 L (16) | 0 | A |
| VES-E-101 VCO | | 5 L | F |
| VES-E-102 VCO | 2610 L (2900) | 1.5 L | F |
| VES-E-103 VCO | 2714 L (3015) | 1.5 L | F |
| VES-E-104 | 185 L (205) | 1 L | F |
| VES-E-106 VCO | 1310 L (1628) | 1.5 L | F |
| VES-E-108 VCO | 2630 L (2920) | 1.5 L | F |
| VES-E-109 VCO | 2610 L (2900) | 1.5 L | F |
| VES-E-110 VCO | 2700 L (3000) | 1.5 L | F |
| VES-E-153 VCO | 2730 L (3050) | 1.5 L | F |
| VES-F-101 VCO | 490 L (550) | 0 | F |
| VES-F-105 VCO | 440 L (460) | 1 L | F |
| VES-F-106 VCO | 440 L (460) | 1 L | F |
| VES-F-107 VCO | 64 L (82) | 0 | F |
| VES-F-108 VCO | 64 L (82) | 0 | F |
| VES-F-119 | 0 L (16) | 0 | F |
| VES-F-130 | 0 L (12) | 0 | F |
| CEN-F-400 VCO | 20 L (30) | 2 L | F |
| CEN-F-401 VCO | 20 L (30) | 2 L | F |
| VES-G-101 VCO | 141 L | 1 L | F |
| VES-G-104 | 12 L | 5 L | F |
| VES-G-105 VCO | 2344 L (2930) | 1.5 L | F |
| VES-G-106 VCO | 2800 L (3620) | 0 | F |
| VES-G-108 VCO | 2344 L (2930) | 1.5 L | F |
| VES-G-111 VCO | 580 L | 1 L | F |
| VES-G-112 | | 0 | F |
| VES-G-113 | | 6 L | F |
| VES-G-115 VCO | 3196 L (3551) | 0 | F |
| VES-G-116 VCO | 3127 L (3475) | 0 | F |
| VES-G-151 VCO | 141 L | 1 L | F |
| VES-G-154 | 12 L | 0.5 L | F |
| VES-G-155 VCO | 2344 L (2930) | 1.5 L | F |
| VES-G-157 | 0 L | 0 | F |
| VES-G-158 | 0 L | 0 | F |
| VES-G-164 | 0 L | 0 | F |
| VES-G-165 | 60 L | 0.5 L | F |
| VES-G-168 | 0 L | 0 | F |
| VES-H-100 VCO | 500 L | 1 L | F |
| VES-H-101 | | 0 | F |

| Idle Process Vessels | Working (overflow) | Residual F = Sampled Flush A = Active | |
|---|---|---|---|
| VES-H-102 | | 5 L | F |
| VES-H-103 VCO | 344 L | 1 L | F |
| VES-H-104 | | 5 L | F |
| VES-H-108 VCO | 2540 L (3070) | 1.5 L | F |
| VES-H-113 | 0 L | 0 | F |
| VES-H-115 VCO | | 7 L | F |
| VES-H-116 VCO | | 7 L | F |
| VES-H-117 VCO | | 7 L | F |
| VES-H-118 VCO | 1010 L (1125) | 1 L | F |
| VES-H-119 | 100 L (132) | 0 | F |
| VES-H-124 | 0 L | 0 | F |
| VES-H-126 | 50 L | 1 L | F |
| VES-H-127 | 0 L | 0 | F |
| VES-H-128 | 0 L | 0 | F |
| VES-H-129 | 0 L | 0 | F |
| EVP-H-130 VCO | 63 L (70) | 0.25 L | F |
| VES-H-131 VCO | 72 L (80) | 0.5 L | F |
| VES-H-132 | 0.5 L | 0.5 L | F |
| VES-H-134 VCO | 100 L | 0.5 L | F |
| VES-H-135 | | 5 L | F |
| VES-H-136 | | 0 | F |
| VES-H-137 | 5 L | 0 | F |
| VES-H-139 | 0 L | 0 | F |
| VES-H-140 | 0 L | 0 | F |
| VES-H-141 | 0 L | 0 | F |
| VES-H-142 | 35 L | 0 | F |
| VES-H-145 VCO | 48 L | 1 L | F |
| VES-H-146 | 0 L | 0 | F |
| VES-J-119 | 0 L (16) | 0 | F |
| VES-J-124 | 0 L | 0 | F |
| VES-J-125 VCO | 63 L (70) | 1 L | F |
| VES-J-127 VCO | 740 L (825) | 0 | F |
| VES-J-128 VCO | 740 L (825) | 0 | F |
| VES-J-134 VCO | 720 L (800) | 0 | F |
| VES-J-135 VCO | 720 L (800) | 0 | F |
| VES-K-104 VCO | | 1 L | |
| VES-K-105 VCO | | 3 L | |
| VES-K-106 VCO | 600 L (670) | 1 L | F |
| VES-K-109 VCO | | 0 | |
| VES-K-110 | | 5 L | |
| VES-K-111 VCO | 300 L (350) | 0 | |
| VES-K-112 VCO | 300 L (350) | 0 | |
| VES-K-113 VCO | 1800 L (2000) | 0.5 L | |
| VES-K-114 | 0 L | 0 | |
| VES-L-101 VCO | 600 L (691) | 3 L | F |
| VES-L-102 VCO | 600 L (689) | 3 L | F |

| Idle Process Vessels | Working (overflow) | Residual<br>F = Sampled Flush<br>A = Active | |
|---|---|---|---|
| VES-L-103 VCO | 650 L (746) | 3 L | F |
| VES-L-104 VCO | 650 L (744) | 3 L | F |
| VES-L-105 VCO | 30 L | 0.5 L | F |
| VES-L-106 | 50 L (60) | 0.5 L | F |
| VES-L-107 | 0 L | 0 | F |
| VES-L-108 | 0 L | 0 | F |
| VES-L-114 | 0 L (16) | 0 | F |
| VES-L-130 VCO | 65 L (75) | 0.5 L | F |
| Heat Exchanger and offgas drain loop seals | 25 x 0.5 L | 12.5 L | F |
| Header piping with no low-point drain | 100 ft 0.15 L/ft | 15 L | F |
| Sumps 23 x VCO | 37 x 0.1 + 5 | 9 L | |
| VES-LC-145 VCO | 0 L (378) | 0 | |
| VES-LC-157 VCO | 32 L | 0 | F |
| VES-LC-158 VCO | 12L | 0 | F |
| VES-LC-162 VCO | 0 L (6) | 0 | F |
| VES-LC-163 VCO | 120 L (150) | 2 L | F |
| VES-M-101 | 450 L (530) | 1 L | F |
| VES-M-102 | 450 L (530) | 1 L | F |
| VES-M-103 | 450 L (530) | 3 L | F |
| VES-M-104 | 450 L (530) | 3 L | F |
| VES-M-111 | 2 L (5) | 0 | F |
| VES-M-112 | 2 L (5) | 0 | F |
| VES-M-113 | 2 L (5) | 0 | F |
| VES-M-114 | 2 L (5) | 0 | F |
| VES-M-110 | 0 L (17) | 0 | F |
| VES-N-100 | 720 L (864) | 3 L | F |
| VES-N-110 | 720 L (864) | 3 L | F |
| VES-N-120 VCO* | 720 L (864) | 3 L | F |
| VES-N-130 | 720 L (864) | 3 L | F |
| VES-N-140 | 720 L (864) | 3 L | F |
| VES-N-150 | 720 L (864) | 3 L | F |
| VES-N-170 | 0 L (12) | 0 | F |
| VES-P-101 | 76 L | 0 | F |
| VES-P-102 | 120 L | 1 L | F |
| VES-P-103 | 2 L (6.8) | 0 | F |
| VES-P-104 | 2.5 L (6.8) | 0 | F |
| VES-P-105 | 2 L (6.8) | 6 L | F |
| VES-P-106 | 86 L | 1 L | F |
| VES-P-107 | 2.5 L (6.8) | 0 | F |
| VES-P-108 | 2 L (6.8) | 5 L | F |
| VES-P-109 | 2 L (6.8) | 0 | F |
| VES-P-110 | 11 L | 0 | F |
| VES-P-111 | 0 L (12) | 0 | F |
| VES-P-115 | 9 L | 0 | F |

| Idle Process Vessels | Working (overflow) | Residual F = Sampled Flush A = Active | |
|---|---|---|---|
| VES-P-118 | 0 L (22) | 0 | F |
| VES-P-119 | 0 L (16) | 0 | F |
| VES-P-120 | 29 L (58) | 1 L | F |
| VES-Q-101 | 78 L | 0 | F |
| VES-Q-102 | 92 L | 1 L | F |
| VES-Q-103 | 2 L (6.8) | 0 | F |
| VES-Q-104 | 2.5 L (6.8) | 0 | F |
| VES-Q-105 | 2 L (6.8) | 5 L | F |
| VES-Q-106 | 68 L | 1 L | F |
| VES-Q-107 | 2.5 L (6.8) | 0 | F |
| VES-Q-108 | 2 L (6.8) | 4 L | F |
| VES-Q-109 | 2 L (6.8) | 0 | F |
| VES-Q-110 | 10 L | 0 | F |
| VES-Q-111 | 0 L (12) | 0 | F |
| VES-Q-115 | 25.3 L (31.5) | 1 L | F |
| VES-Q-116 | 30 L (41) | 0.5 L | F |
| VES-Q-117 | 0 L (17) | 0 | F |
| VES-Q-118 | 0 L (22) | 0 | F |
| VES-Q-119 | 0 L (16) | 0 | F |
| VES-Q-120 VCO | 7 L (13.9) | 1 L | F |
| VES-Q-901 | 1 L | 0 | F |
| VES-S-111 | 0 L (12) | 0 | F |
| VES-S-116 | 65 L (75) | 3 L | F |
| VES-S-117 | 3 L (8) | 0 | F |
| VES-T-100 VCO | 5200 L (6284) | 0 | F |
| VES-T-101 VCO | 1700 L (1893) | 0 | F |
| VES-T-102 VCO | 680 L (757) | 0 | F |
| VES-T-103 VCO | 680 L (757) | 0 | F |
| VES-U-101 VCO | 590 L (725) | 3 L | F |
| VES-U-111 VCO | 590 L (725) | 3 L | F |
| VES-U-121 VCO | 590 L (725) | 3 L | F |
| VES-W-101VCO | 620 L (728) | 3 L | F |
| VES-W-111VCO | 620 L (728) | 3 L | F |
| VES-W-121 VCO | 620 L (728) | 3 L | F |
| VES-W-129 VCO | 4500 L (5700) | 0 L | F |
| VES-Y-101 VCO | 650 L (695) | 3 L | F |
| VES-Y-119 | 0 L (16) | 0 | F |
| VES-Y-121 VCO | 600 L (670) | 3 L | F |
| VES-Z-101 | 115 L (220) | 0 | F |
| VES-Z-104 | 135 L (220) | 0 | F |
| VES-Z-107 | 135 L (220) | 0 | F |
| VES-Z-120 VCO | 0 L (38) | 0 | F |
| VES-Z-123 VCO | 0 L (4) | 0 | F |
| VES-HC5-100 VCO | | 0.5L | F |
| VES-HC5-101 VCO | | 1.5L | F |
| VES-HC2-107 | 0 L | 0 | F |

| Idle Process Vessels | Working (overflow) | Residual F = Sampled Flush A = Active | |
|---|---|---|---|
| VES-HC2-108 VCO | | 0 | F |
| VES-HC2-109 | | 0 | F |
| VES-HC2-110 | 0 L | 0 | F |
| VES-HC2-121 VCO | | 1 L | F |
| VES-HC2-152 VCO | | 0 | F |
| VES-HC2-153 VCO | | 1.5 L | F |
| VES-HC2-400 | 0 L | 0 | F |
| VES-627-103 VCO | | 0 | |

| Interim Status Waste Vessels | Working (overflow) | Residual F = Sampled Flush A = Active | |
|---|---|---|---|
| VES-WG-100 | 13700 L (17500) | 25 l | A |
| | | | |
| VES-WH-100 | 13700 L (17500) | 25 L | A |
| VES-WH-101 | 13700 L (17500) | 25 L | A |
| VES-HW-100 | 1750 L (1900) | 14 L | |
| VES-HW-101 | 1750 L (1900) | 14 L | |
| VES-HW-102 | 1750 L (1900) | 14 L | A |

| Abandoned Vessels | Working (overflow) | Residual F = Sampled Flush A = Active |
|---|---|---|
| VES-E-105 | 57 L | 0 |
| VES-E-151 VCO | 96 L (114) | 0 |
| VES-E-351 | | 0 |
| VES-HC2-151 VCO | 428 L | 0 |
| VES-H-120A and B | 28 L | 1 L |
| VES-J-117 VCO | 760 L | 2 L |
| VES-J-131 VCO | 64 L | 47 L |
| VES-P-102A | 120 L | 0 |
| VES-P-106A | 86 L | 0 |
| VES-PA-102 VCO | 68 L | 1 L |
| VES-S-115 | 40 L | 0 |
| VES-U-129 VCO | 1064 L | 2 L |
| VES-U-300 VCO | | 0 |
| VES-U-130 VCO | 1064 L | 2 L |
| VES-U-301 VCO | | 0 |
| VES-VT-100 | 380 L | 0 |
| VES-VT-101 | 380 L | 0 |
| VES-Y-140 VCO | 627 L | 0 |
| VES-Y-300 | | 0 |
| VES-Y-150 VCO | 16 L | 0 |
| VES-Y-160 VCO | 780 L | 7 L |
| VES-Y-161 VCO | 42 L | 0 |

**SUMMARY OF RESIDUAL VOLUMES:**

Estimated Idle Process Residual = 232 L = 61 GAL**
Estimated Abandoned Vessel Residual = 16.5 GAL
Estimated Sump Residual = 9 L = 2.5 GAL*
Estimated Interim Status Unit Tank Residual=142 L=37.5 GAL*

** 60 GAL now consists of sample flush solution, last gallon will be flush solution after proposed final tank rinse

- All will be flush solution after proposed final tank and cell floor rinse

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## 3.4 Actual and Potential Leaks Under the FRC

During 1989, an attempt was made to verify the integrity of the directly buried PEW lines under CPP-601. The examination showed that the piping system had some leaks, and led to the replacement of the original PEW collection system with a new RCRA-compliant system. The locations of suspected leaks are shown in Figure 3-1 and 3-2.

The first effort was a visual inspection of the lines emerging from the soil into the CPP-601 waste trench. Several leaks were found where welds had corroded, allowing solution to leak to the floor of the waste trench. In the most severe of these, it appeared that incorrect weld-wire had been used. Evidence was also found that leakage had occurred into the trench around the headers coming from CPP-602. Inspection of the CPP-602 waste trench revealed leaks from the collection header loop seals. The CPP-602 trench was constructed of unlined concrete. There was evidence, in the form of an etched high-water mark in the concrete of the trench, that the system had operated for an extended period of time with the sump and lower portion of the trench full of mildly corrosive liquid. The approximate depth of liquid at the sump was 25 feet. The bottom of the sump, adjoining the north wall of CPP-601, was poured with a tarpaper cold joint. The concrete at the bottom of the sump had deteriorated to the condition that a cold chisel could be driven through it with a single hammer blow. A sample of this concrete tested negative for mercury. It is highly likely that leakage to the soil occurred from the bottom of this sump, especially when it was operating in the flooded condition (1, Figures 3-1, 3-2). Water from the bottom of the CPP-602 sump also leaked into the CPP-601 waste trench. Due to an improper setting for the WT-101 sump alarm, this leak was not detected, and the liquid continued into the WG/WH tank vaults. For a period of at least several months, the WG/WH vaults were filled with liquid to a depth of nearly 4 feet. This liquid backed into the old ventilation outlet ducts for the tank vaults. These ducts were made of unlined concrete, with cold joints at the bottom and along the outside walls of the tank vaults. Some liquid could have leaked to the soil from the flooded ducts (2, Figures 3-1, 3-2).

The second examination effort consisted of running a boroscope video camera down some of the buried pipes. The first examination was done on a K-cell wall drain. The camera showed that the roots of all the welds had corroded away. The camera reached a point where one of the welds could also be examined in the waste trench. The external cover passes on this weld were thick enough to provide a good seal even though the root was gone. The second

| REVISIONS | | |
|---|---|---|
| REV | DESCRIPTION | EFFECTIVE DATE: |

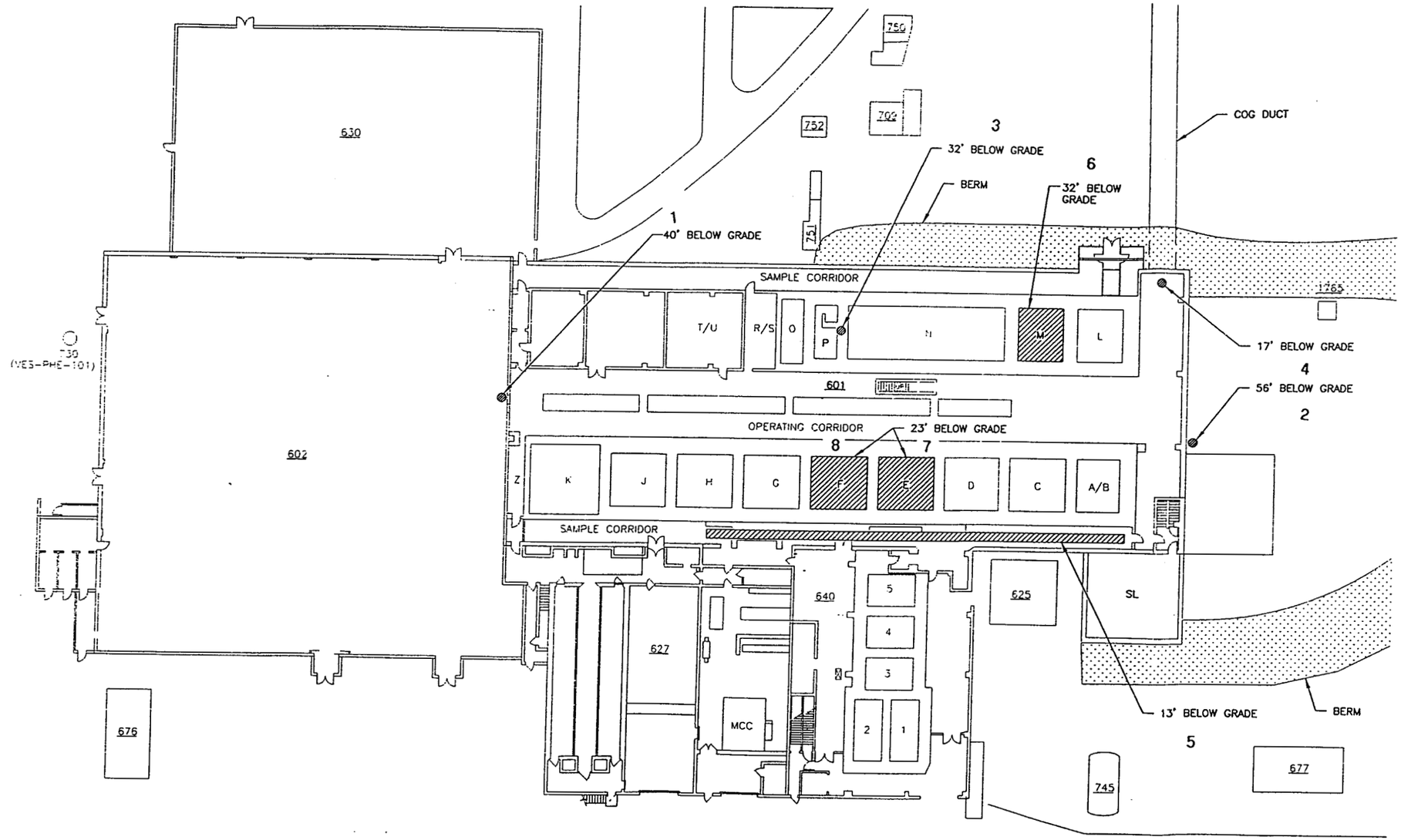


FIGURE 3-1 Potential Leakage Beneath the FRC, Plan View

| | |
|---|---|
| SUBCONTRACT NO. | LOCKHEED MARTIN |
| REQUESTER: ED WAGNER | INTEC BLDG 601 WITH SURROUNDING BLDGS & STRS |
| DESIGN: | GRADE = 0'-00" |
| DRAWN: M. CHRISTENSEN | SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CI, ORG 530; DWG-; REV |
| PROJECT NO. | SCALE: NONE; SHEET 1 OF 1 |
| SPEC CODE | |
| FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. | |
| EFFECTIVE DATE: | |

File: 3646-PLAN.dwg
Path: P:\Wapser-3646
User: MCX
Date: 04/28/99 - 10:03 A.M.

| REVISIONS | | |
|---|---|---|
| REV | DESCRIPTION | EFFECTIVE DATE: |

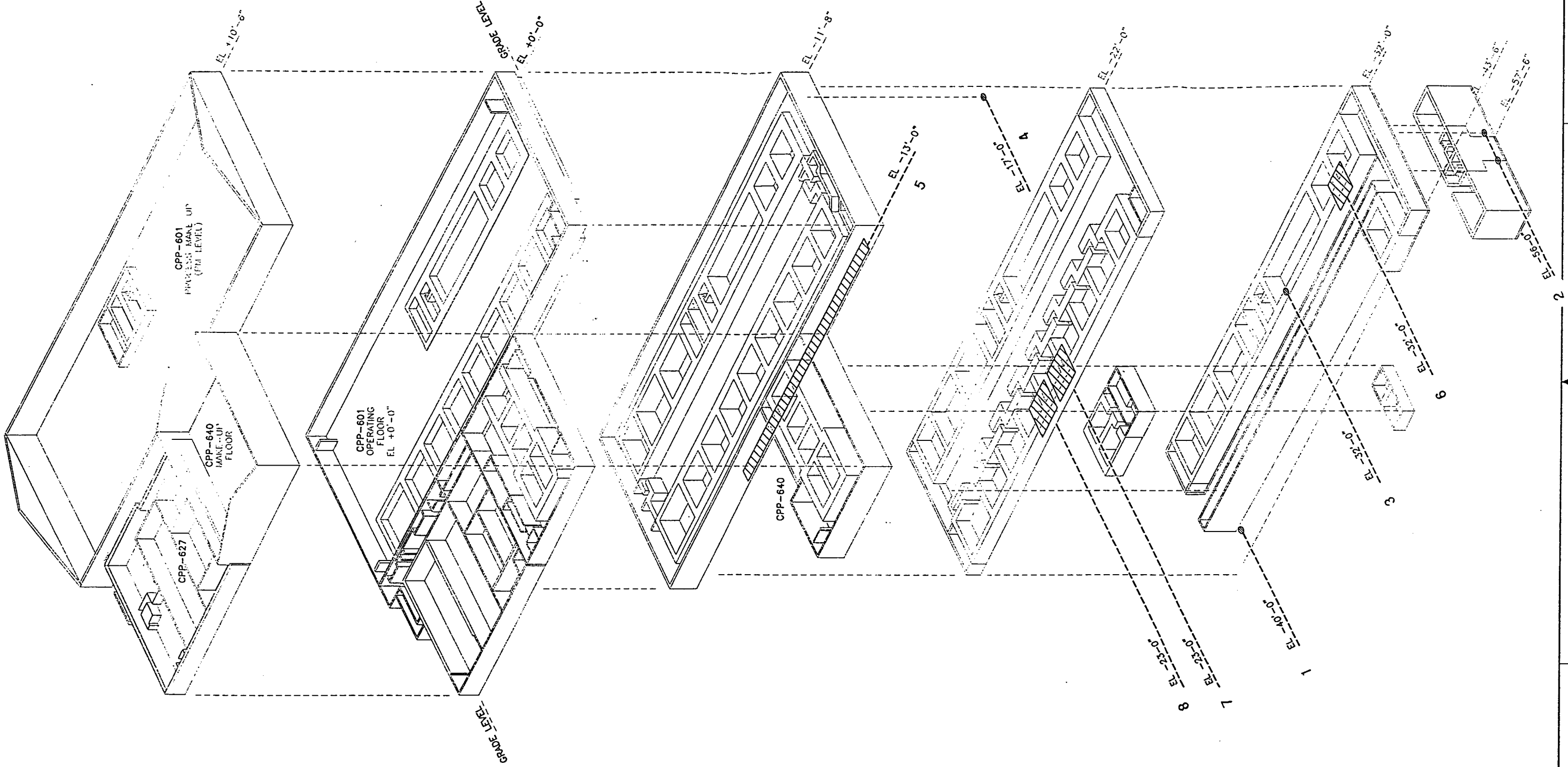


FIGURE 3-2 Potential Leakage Beneath the FRC, Exploded View

| | |
|---|---|
| SUBCONTRACT NO. | LOCKHEED MARTIN |
| REQUESTER: E. WAGNER | INTEC BLDG 601 AND ADJOINING BUILDINGS 620 AND 640 EXPLODED 3 DIMENSIONAL VIEW |
| DESIGN: | |
| DRAWN: M.CHRISTENSEN | |
| PROJECT NO. | |
| SPEC CODE | |
| FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. | SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, DISC 530; DWG-3646-3D; REV |
| EFFECTIVE DATE: | SCALE: NONE; SHEET 1 OF 1 |

ADOCS NO.

pipe examined was the Q-cell wall drain. This pipe could only be examined for a short distance before progress was blocked at a weld by a piece of welding rod that extended through the pipe wall and all the way across the center of the pipe. The root of this weld, and the others examined, was corroded. The third pipe examined was the P-cell wall drain. The vertical run of this pipe could be examined for about 10 feet until a 90° bend at a tee was encountered. As before, weld roots were corroded. One weld appeared to have never been completed, showing evidence of three tack welds, but no circumferential welding. This 'air-weld' was located in the soil beneath the building (3, Figures 3-1, 3-2). After that, it was conceded that the pipes under the building were not fit for continued use. Leakage to the soil was certain from the area of the incomplete weld, and statistically probable from other undiscovered sources.

The third phase of the examination looked at the cast iron pipes under the vent tunnels. The line under the east vent tunnel was accessible in three locations by hatches leading to the 'crypts' under the vent tunnel. The line appeared undamaged in all three locations. The extension under the south vent tunnel was checked by attempting to add water to the deep tanks via the floor drain used by the VT-300 condensate line. Rapid addition of over 100 gallons of water from a metered garden hose showed that no water reached the tanks, and that no water backed up in the drain. Visual examination of the drain revealed that all pipe material had corroded away, leaving a hole outlined by exposed concrete aggregate in the floor slab and compacted gravel fill under the building. The 1.5 rem/hr gamma field from the hole limited examination time and efforts to obtain soil samples. This is currently the only identified CERCLA site (ECA-CPP-80) under CPP-601 (4, Figures 3-1, 3-2).

Leaks from process lines, prior to 1983, had caused extensive contamination and high radiation fields in the west vent tunnel. Cleanup efforts included use of corrosive decontamination solutions and physical removal of thin layers of concrete by scabbling and water blasting. The cast iron line under the west vent tunnel had failed during these, or previous decontamination efforts. The line had been capped in the WG tank vault, and the inlets from the vent tunnel were capped. A new floor of concrete over lead sheeting was poured in the west vent tunnel. New drain lines had been installed to the wall drains in K, F, and C-cells. These new drains were still not compliant with RCRA since they could not be checked for leakage. The vent tunnel floor was not pitched for drainage and was not lined with a material compatible with waste or process solutions. Damage to the floor was noted due to leakage from a decontamination spray header. The concrete cold joint between the CPP-640 vent tunnel and CPP-601 west vent tunnel had a large crack which could also have allowed contaminated liquid to leak to the soil beneath the vent tunnels. It is speculated that contamination entering CPP-640 at the access level wall joint with CPP-601 may originate from the damaged cast iron line under the west vent tunnel. No portion of this cast iron line was accessible for examination (5, Figures 3-1, 3-2).

There are also three cases of known leakage through stainless steel cell floor liners, in which solution was known to have entered the space between the liner and the concrete floor. It cannot be told if any solution penetrated the floor through cracks or cold joints along the walls to reach the soil below the building.

During water flooding of the M-cell floor to verify the depth of borated glass Raschig rings, water was observed leaking into the cell entry area from behind the cell liner. The leak was never found, but was at least 3 inches up the wall. The leak was first observed when clean water was being used. It is possible that small amounts of hazardous material entered the space under the liner during later decontamination efforts (6, Figures 3-1, 3-2).

During the last zirconium dissolution campaign in E-cell (1980), a leak in one of the dissolvent addition lines allowed hydrofluoric acid to spill onto the floor liner. Use of the line was terminated, but small quantities of dissolver product also reached the floor liner from this leak. During decontamination efforts after the campaign, several small pinholes were observed in the liner (solution squirted up when workers stepped near the holes). At the start of decontamination efforts, the floor area was over 200 rem/hr. Cleaning techniques included flooding the floor with decontamination solutions and nitric acid, then recirculating the liquid with a steam jet. Final radiation levels were under 200 mrem/hr. It could not be verified whether all contaminants were cleaned up into the cell, or if some were flushed down into the soil (7, Figures 3-1, 3-2).

During the same campaign (1980), recirculating pumps for contaminated DOG scrubber solution leaked onto the floor liner in F-cell. In an attempt to reduce exposure to workers, the F-cell floor was flooded with water to a depth of several inches. Decontamination efforts after the campaign were unable to reduce radiation fields near the F-cell sump below 4 to 5 rem/hr. This situation remained unresolved until 1990. At that time a core drill was being made into F-cell near floor level as part of the buried lines replacement project. The lubricating water from the core-drilling machine began to show up on the F-cell floor. The water was highly contaminated, but the flow path was obscured by lead shielding blankets on the floor. An attempt to trace the water flow was made by welding a pipe stub to the floor liner and drilling a hole through the liner. The stub was then filled with dye, and flush water was introduced from a garden hose. The water emerged around two holes for the anchor bolts that secured the cell ladder. No seal welds had been made during the ladder installation (late 1970's). The first water emerging from the hole read nearly 10 rem/hr. Continued flushing rapidly reduced the activity in the water emerging from the holes and reduced the field near the cell sump to ~200 mrem/hr. There was no way to verify if all solution entered the cell or if some flushed down into the soil (8, Figures 3-1, 3-2).

The lines buried under CPP-627 and CPP-640 were not accessible for external examination. Based on the evidence from the CPP-601 piping, it was decided to abandon the buried lines under these buildings as well.

Under the Federal Facilities Agreement/Consent Order, provisions are being made to conduct the investigation and cleanup of releases or potential releases under the CERCLA process. This system of piping will be included as a new site identification in operable unit (OU) 3-13 in WAG 3 for investigation.

## 3.5 Lead in the FRC

Lead exists throughout the FRC in several forms. Most of the mass of lead is in the form of lead bricks and cast lead. Smaller amounts are found as lead sheets, lead shot, and lead wool. Lead flashing and washers were used to fasten and seal structural transite panels. Lead paint was also used in the FRC, most often as a primer on carbon steel. The total mass of lead in the FRC is in the range of 482 tons. This is equivalent to a solid lead cube 11.1 feet on each edge. Location and estimated mass of lead is summarized in Table 3-5.

***Lead brick:*** Lead bricks were used to form enclosures for radioactively contaminated equipment that was likely to require periodic access for maintenance. Shielding blisters of this type were built around pumps PA-209 and PA-210 in the access corridor, and pumps PA-201,

**Table 3-5**
**Lead in the FRC**

***CPP-601 Lead***

***Truly structural***

| | | | |
|---|---|---|---|
| G-roof | 95.2 $ft^3$ | | 33.9 tons |
| G-cave | 36.7 $ft^3$ | | 13.1 tons |
| C&D roofs | 2.5 $ft^3$ | | 0.9 tons |
| Slide valves | 2.8 $ft^3$ x 7 | | 7.0 tons |
| East Vent | 46.0 $ft^3$ | | 16.3 tons |
| Service Corridor | 207.9 $ft^3$ | | 74.0 tons |
| Sample Galleries 1, 3, 4, 5, 6, 12, 13, 15 | 137.4 $ft^3$ | | 48.9 tons |
| Sample galleries 10 and 11* | 38.4 $ft^3$ | | 13.6 tons |
| Valve handle sleeves | | 50 x 50 lbs. | 1.3 tons |
| PA – H-cell | 8 $ft^3$ | | 2.9 tons |
| PEW in PA | | | 6.0 tons |
| PA – F-cell | 2.2 $ft^3$ | | 0.8 tons |
| X-cell Cave | 25.6 $ft^3$ | | 9.1 tons |
| East Vent floor | 8 $ft^3$ | | 2.9 tons |
| Sample cubicles | 25.5 $ft^3$ | | 9.5 tons |
| Rala | 6.9 $ft^3$ | | 2.4 tons |
| | | | 242.6 tons |

***Stacked Bricks, Castings, and Shot***

| | | | |
|---|---|---|---|
| PM-268* | | 468 bricks | 6.6 tons |
| H-132 | | 240 bricks | 3.4 tons |
| Sample galleries 10 and 11* | | 120 bricks | 1.7 tons |
| PA-201/202 | | 869 bricks | 12.2 tons |
| PA-203/204 | | 495 bricks | 6.9 tons |
| PA-209/210 | | 500 bricks | 7.0 tons |
| PA-400 area | | ~200 bricks | ~3 tons |
| PT lines | 71.4 $ft^3$ | | 25.4 tons |
| X-cell bricks | | 244 bricks | 3.4 tons |
| PTS lines* | 7.1 $ft^3$ shot | | 1.8 tons |
| MCC casks | 3 @ 2.2 tons | | 6.6 tons |
| | | | 78.0 tons |

***Total:*** ***320.6 tons***

**Table 3-5**
**Lead in the FRC (con't)**

***CPP-627 Lead***

| | | | |
|---|---|---|---|
| RAF boxes (H) | 85.2 $ft^3$ | | 30.3 tons |
| RAF boxes (L) | 65.6 $ft^3$ | | 65.6 tons |
| RAF line ends | 4.2 $ft^3$ | | 1.5 tons |
| RAF shield plugs | 2.3 $ft^3$ | | 0.8 tons |
| MCC | | 216 bricks | 3 tons |
| Duct wrap | 1.1 $ft^3$ | | 0.4 tons |
| RAF cave | 51 $ft^3$ | | 18 tons |

***Total:***

***119.6 tons***

***CPP-640 Lead***

| | | | |
|---|---|---|---|
| Slide valve | 2.8 $ft^3$ | | 1.0 ton |
| Pipe slots | | 35 x 26 = 910 br | 12.7 tons |
| Line wrap | 1.3 $ft^3$ | | 0.5 ton |
| Manipulators | | 10 x 5 = 50 brick | 0.7 ton |
| Window shims | 2.8 $ft^3$ | | 1.0 ton |
| K-plug seals | 7.4 $ft^3$ | | 2.6 tons |
| Cell 2 north wall | 32 $ft^3$ | | 11.4 tons |
| HC5 sampler | 5.6 $ft^3$ | | 2.0 tons |
| Rover samplers | 20 $ft^3$ | | 7.1 tons |
| HW sampler | 3.43 $ft^3$ | | 1.2 tons |
| MHC filter | 1 $ft^3$ shot | | 0.3 tons |
| Valve handle sleeves | | 12 x 50 lbs. | 0.3 tons |

***Total:***

***40.8 tons***

***Grand total: 481 tons + ~1 ton miscellaneous sheeting, shot, and wool.***

Total that must be removed in upper PM area (marked with*): 48.1 tons, leaving 432.9 tons. Additional that could be removed with a lot of effort: 61.7 tons, leaving 371.2 tons.

PA-202, PA-203, and PA-204 in O-cell. The enclosures in the PM area for the Clarkson feeder (PM-268) and for the H-132 uranium monitor were also constructed of lead bricks.

Some bricks from a former enclosure around a centrifuge station in the access corridor were stacked on top of the concrete slab that was poured over the contaminated area after the centrifuge was removed.

The floor of the operating pit in front of the G-100 charging cave is built of lead bricks. Several lead shielding structures are embedded in the concrete in or near the G-100 cave.

In the east vent tunnel, shielded raceways for waste pipes from the STR/SIR process and the RALA process were constructed from lead bricks. The total length of these raceways is ~150 feet. Much of the lead is held in place by grout.

Channels for waste piping under the service corridor floor were shielded with lead bricks. These channels have a total length of ~130 feet. The stainless steel floor liner of the service corridor would have to be removed to provide access to the bricks.

The cells in CPP-640 were constructed with numerous pipe slots for future use. The outside access to these slots (~ 6" x 8" x 36") is blocked with lead bricks. Some of the CPP-640 sample stations and the wall opening for the old rotary transfer station also utilize lead bricks.

In CPP-601, lead bricks were used to shield access ports around sample stations and the G-100 charging cave. This type of usage also occurs in the RAF and MCC areas of CPP-627.

Lead bricks were used as counterweights on master/slave manipulators throughout the FRC.

***Cast lead:*** Numerous permanent shielding structures were constructed from welded steel plate boxes filled with molten lead. These structures include sample galleries (2 in the PM area, 4 in the east sample corridor, 2 in the west sample corridor, 2 in the WA/WF control rooms, 2 in the CPP-640 sample corridor, and one in the CPP-640 access area). Portions of the shielded glove box lines in the RAF were constructed in a similar manner.

The X-cell cave was constructed from lead filled steel forms and lead bricks.

The rear and roof of the G-100 charging cave, and the plug in the top of the channel containing the G-164 vessel, are also made from steel forms containing cast lead.

Lead shielding for several lines in the service corridor was made from half cylinders of cast lead. The total length of shielded lines is ~400 feet.

Lead castings were used to shield a detector port by the old RALA window in the south access corridor and a pipe chase in the PM area floor.

Lead castings were used to shield valve handle penetrations in the CPP-601 east and west sample corridors and the CPP-640 sample corridors (~75 total).

Slide valves for the fuel charging chutes were made from lead-filled steel boxes (seven in CPP-601, one in CPP-640).

Three lead filled steel casks designed for use in the MCC are being stored in the PM area.

Cast iron piping, found under the CPP-601 vent tunnels, used cast lead in bell joints between pipe sections.

***Lead sheets:*** Lead sheets were used to wrap 'hot spots' that developed in some lines. Often the use was intended to be temporary, but some of the sheets have been in place for decades. Lead sheet shielding can be found around the WG/WH recycle lines in the south access corridor. Small bits of lead sheet can be found around pipe penetrations to process cells in CPP-601 and CPP-640.

The new PEW collection header in the south access corridor is shielded with hammered lead sheeting – effectively forming a single mass of lead.

Lead sheets were placed over hot spots in the old west vent tunnel floor and covered with the new concrete floor.

Some lead sheets and/or lead bricks are still in place behind the CPP-601 instrument panels.

***Lead shot:*** Lead shot was poured into irregular spaces around some shielding windows and pipe penetrations. Shielding windows with lead shot can be found in CPP-601, and CPP-640.

Lead shot was also poured into the filter access port for the MHC.

Lead shot was poured into ventilation pipe penetrations in the south access corridor and a steam pipe penetration in the east sample corridor. It was also used to shield some PTS transport air lines in the west sample corridor and the PTS doghouse and the PEW pumpout line in the access corridor.

***Lead wool:*** Lead wool was tamped into some penetrations where more than one small line fed through a larger penetration. It was also used as 'caulking' between castings. Examples exist in the MHC, RAF, RALA, and some penetrations into the service corridor.

***Lead blankets:*** Lead blankets (lead wool encased in flexible plastic sheets) were used for temporary shielding. Some shielding, such as that wrapped around the PEW VOG line in the south access corridor, has been in place for nearly ten years.

## 3.6 Asbestos

Asbestos exists in several forms in the FRC. Original construction included asbestos containing floor tiles and transite wall and roof panels. Some mastics used in roof repair also contained asbestos. Insulation on steam and water piping was originally asbestos, and until the middle 1980's, repairs used asbestos containing materials. All piping insulation must be regarded as containing asbestos unless specifically sampled.

The primary use of transite is in the CPP-601 and CPP-640 roofs, and the walls of the CPP-601 PM area. Asbestos tiles exist in the floors of all three buildings in the FRC.

Process cells are generally asbestos free, since insulation was not compatible with decontamination requirements. Friable asbestos in the Rover dry process cells was abated. The exception is a ventilation line running through HC3 and HC4 to the MHC. This undamaged insulation was left in place because access for removal was too difficult. Some wiring abandoned in place with VES-HC3-100 and VES-HC3-104 is covered with asbestos insulation.

## 3.7 PCB

The only source of PCB in the FRC is from paint. Small amounts of PCB were used as a plasticizer in some types of paint. Paint samples have been taken in the FRC, and PCB was detected in some of the red paint used on firewater lines, in the CPP-601 PM area.

## 3.8 Mercury

Electrical switches using mercury contacts were in common use during the time of construction and operation of the FRC. It is expected that numerous mercury switches still exist in the FRC.

## 3.9 Radioactive Waste

### 3.9.1 Contamination

Even after extensive flushing, all process equipment, piping, and cell spaces retain varying degrees of radioactive contamination. Table 3-6 gives the most current values for general radiation fields in the process cells. Although these fields are very low compared to those present during operation, they are high enough to cause high doses to workers who may be required to spend many hours working in these areas. There are also "hot spots" of higher radiation that must be addressed during planning of any work in the process cells. Process area radiation fields are summarized in Table 3-6.

Equipment connected to process vessels, such as sample and instrument galleries, steam or air piping connected to jets and sparges, and chemical addition piping is internally contaminated. Effective contamination control measures must be implemented during any demolition activities affecting these items.

Much smaller amounts of contamination may be encountered in areas such as the operating corridor, PM area, and sample corridors. This contamination is due to past releases from process lines and instruments. Extensive cleanup has taken place, but some contamination is lodged in difficult areas such as under mounting plates, crevices in instrument panels, and cracks in walls. In some areas, contamination was fixed in place by painting or covering with new flooring material.

### 3.9.2 Fissile Material

Estimates have been made of residual uranium in the FRC (DLO-02-96). These estimates were prepared for purposes of criticality safety and nuclear material accountability, which require estimates to be conservatively high.

Estimates for CPP-601 are reasonable. The estimates made for CPP-640 and CPP-627 appear to be at least an order of magnitude too high. Table 3-7 summarizes current estimates of uranium residuals. It includes the uranium bearing material that was grouted in place in VES-HC-100 and VES-HC3-104, and the small amount in VES-HCC-106 that will be grouted along with HC3 itself. Criticality safety personnel have approved this grout placement as a means of immobilizing the uranium and eliminating criticality hazards.

*Table 3-6*
**CPP-601 Process Area Radiation Fields**

| *Area* | *Contamination Status* | *General Body Field (GBF)* |
|---|---|---|
| A Cell | Low Level | < 5 mrem/h |
| B Cell | Low Level | < 5 mrem/h |
| C Cell | Low Level | 60 mrem/h |
| D Cell | Low Level | 10 mrem/h |
| E Cell | Contamination | 150 mrem/h |
| F Cell | High Level | 300 mrem/h |
| G Cell | High Level | 200 mrem/h |
| H Cell | Contamination | 50 mrem/h |
| J Cell | Contamination | 3 mrem/h |
| K Cell | Low Level | 15 mrem/h |
| L Cell | Contamination | 250 mrem/h |
| M Cell | Contamination | 25 mrem/h |
| N Cell | Contamination | 450 mrem/h |
| O Cell | Contamination | 3 mrem/h |
| P Cell | Contamination | 50 mrem/h |
| Q Cell | Contamination | 30 mrem/h |
| R Cell | No Survey Data | <20 mrem/h |
| S Cell | High Level | 20 mrem/h |
| T Cell | No Detectable | <1 mrem/h |
| U Cell | Contamination | 50 mrem/h |
| W Cell | Contamination | 5 mrem/h |
| X Cell | Low Level | <5 mrem/h |
| Y Cell | Contamination | 5 mrem/h |
| Z Cell | Contamination | 1 mrem/h |
| E. Vent Tun. | High Level | 5 mrem/h |
| S. Vent Tun. | Contamination | 50 mrem/h |
| W. Vent Tun. | Contamination | 20 mrem/h |
| W.H. Vault | High Level | 100 mrem/h |
| W.G. Vault | High Level | 1,000 mrem/h |
| WB Pump Pit | High Level | 30 mrem/h |
| WC Pump Pit | High Level | 30 mrem/h est |
| WD Pump Pit | High Level | 30 mrem/h est |
| WE Pump Pit | High Level | 30 mrem/h est |
| Access Cor. | Low Level | 5 mrem/h |
| Service Cor. | Contamination | 20 mrem/h |
| HC1 | Contamination | <5 mrem/h |
| HC2 | Contamination | <50 mrem/h |
| HC3 | Contamination | <10 mrem/h |
| HC4 | Contamination | <10 mrem/h |
| HC5 | High Level | 20,000 mrem/h |
| MHC | Contamination | <5 mrem/h |
| MCC | Low Level | <10 mrem/h |
| RAF | Contamination | 50 mrem/h |

## Table 3-7
## Estimated Uranium Residuals in the FRC

| Process Streams | Cells | Uranium in Cells (g) (from DLO-02-96) | Uranium (g) corrected using later information |
|---|---|---|---|
| ***Dissolver Product*** (generic headend fuel) | PM-268 (Feeder) | 2.35 | |
| | C & L | 20.00 | |
| | E | 5.40 | |
| | F | 7.20 | |
| | F,G, H Sample Cubicle | 1.00 | |
| | 1 G/Alum. Cave | 104.35 | |
| | J | 1.28 | |
| | L, M Sample Cubicle | 2.50 | |
| | U | 1.20 | |
| | W | 3.88 | |
| | Y | 0.75 | |
| | WG/WH | 30.00 | 1 |
| | ***Total*** | ***157.56*** | ***129*** |
| ***H-Cell Chemistry*** | ***1 H*** | ***32.61*** | ***33*** |
| ***TBP Recycle Stream*** | ***1 H*** | ***13.04*** | ***13*** |
| ***1st Cycle Product*** | M | 30.96 | |
| | N | 36.40 | |
| | O | 10.00 | |
| | ***Total*** | ***67.36*** | ***68*** |
| ***2 & 3 Cycle Chemistry*** | P | 0.86 | |
| | P-cell fittings | 2.50 | |
| | Q | 1.86 | |
| | Q-201 Pump | 2.50 | |
| | ***Total*** | ***5.22*** | ***5*** |
| ***2 & 3 Cycle Product*** | R/S | 1.5 | |
| | Z | 0.98 | |
| | Denitrator/LC-163 | 2.79 | |
| | ***Total*** | ***5.27*** | ***5*** |
| ***Hexone Recycle*** | ***K*** | ***1.06*** | ***1*** |
| ***Generic Laboratory*** | X-Cell | 15.00 | 1 |
| | Shift lab | 15.00 | 0 |
| | RAF | 15.00 | 1 |
| | DDL | 15.00 | 0 |
| | ESL | 15.00 | 0 |
| | HCL | 15.00 | 0 |
| | MCC-Anteroom | 15.00 | 1 |
| | ***Total*** | ***105.00*** | ***3*** |

**Table 3-7**
**Estimated Uranium Residuals in the FRC**

| Process Streams | Cells | Uranium in Cells (g) (from DLO-02-96) | Uranium (g) corrected using later information |
|---|---|---|---|
| *Rover "Dry" Side* | *Cell 3 & 4/MHC* | *15.00* | *31 + 828 in grout** |
| *Electrolytic* | *Cell 5* | *350.00* | *5* |
| | *Grand Total* | *1,102.12* | *308 + 828 in grout** |

1 G & H cells were flushed as one unit, but the volume split is G-16,000 L/H extract. –5000 L/TBP –2000L
* Uranium grouted in process vessels following extensive removal efforts is recognized as immobile and poses no criticality hazard.

# 4.0 PROPOSED ACTIONS

## 4.1 Final State of FRC

The proposed final state of the FRC is a grout filled monolith covered with an impermeable cap. The logical approach is to retain the existing shielding structures intact and collapse or remove the higher structure, piping and vessels. This would result in a platform approximately 250 feet by 200 feet at an elevation of 11 feet above grade. There would be two higher spots - a 20 x 30 foot area reaching 19 feet above grade (P, Q, S cells), and an 18 x 33 foot area reaching 24 feet above grade (MHC). Debris from the upper structure would be stacked between the high points and the G-cell charging cave in a manner to produce a saddle-shaped cap for proper drainage. Alternatives, such as cutting off the shielding structure at ground level, are still being evaluated. The expense and risks of worker exposure and loss of contamination control are expected to be many times higher than for leaving the structure intact.

## 4.2 Proposed Disposition of Wastes

Extensive work has already been done in cleaning up the FRC. Prior to mission termination, the first cycle cells had been subjected to extensive chemical decontamination to prepare for maintenance and construction activities. Many additional plant areas were decontaminated prior to the buried line replacement project. It was determined that further chemical decontamination of the process cells was not justified, due to the difficulty in disposing of the waste generated and the minimal personnel access required for the idle facility. Documented records of these flushes show that over 200,000 gallons of high sodium mixed waste were discharged to the tank farm during this effort. This effort also removed a minimum of 12,000 curies of radioisotopes from the FRC. An attempt to further reduce residual waste in the facility using chemical decontamination could easily generate as much waste volume, with no significant benefit in terms of waste removal.

Following the termination of the reprocessing mission, the CPP-601 and CPP-640 process cells were subject to extensive flushing. The first round of flushes was aimed at uranium recovery. These flushes were conducted according to approved procedures and the results were examined and approved by organizations in charge of uranium accountability and criticality safety (letters KBF-009-94, KBF-026-94, DLO-02-96, DLO-03-96, JTT-12-96).

A second round of flushing was conducted to assure removal of RCRA hazardous materials. These flushes consisted of dilute nitric, followed by three water rinses. The flushes were patterned after the uranium recovery operations, moving solution through the many possible transfer routes, and gathering the flush solution in one or two vessels for sampling. The procedures, sample protocols, and sample results were reviewed and approved by the responsible environmental organizations. Additionally, the process cells were entered and rinsed with water. However, these cell rinses were not sampled, so no credit will be taken for them.

There is currently no agreed value for "adequately clean" within LMITCO, or between DOE and the state regulatory authorities. The value accepted for "adequately clean" must balance the risk associated with leaving a small amount of waste in place against the risks involved with removal. At INTEC, there are significant hazards of both radiological (radiation fields and loose contamination) and industrial safety (confined space, poor ventilation, fall

protection) nature. Waste removal can also generate significant additional waste streams, including personal protective equipment, industrial debris, and cleaning solutions. It is often possible for a 'cleanup' operation to generate far more waste than it removes.

### 4.2.1 Inactive Systems with Documented Flushes

It is proposed that the portions of the process which have undergone the documented flushing sequences described above be declared 'adequately clean'. This determination is based on recognition of the extensive efforts already expended on cleaning the system. Completed vessel flushes are summarized in Table 4-1. Detailed procedures and sample results are contained in Appendix C.

### 4.2.2 Currently Active Systems and Inactive Systems without Documented Flushes

A project is underway to reroute active PEW collection lines and chemical transfer lines around CPP-601. After the new lines are put in service, the FRC will be isolated from sources of RCRA hazardous wastes. At that time, those portions of the PEW system and chemical makeup system that were still active will be given an equivalent sequence of flushes to that received by the previously inactivated equipment. Vessels in K-cell and the PM area that have not been adequately flushed will be flushed and sampled. Cell floors and sumps that were not included in previously documented flushes will be flushed. These external flushes of cell floors and sumps will use water to minimize the hazard to personnel. A proposed flushing and sampling sequence is described in Appendix D.

### 4.2.3 Abandoned Lines and Vessels

Those portions of the abandoned PEW ancillary piping which are partially or completely buried in soil without a RCRA compliant secondary containment will be left as is. The slope of the piping would have allowed nearly all solution to drain away, leaving only traces of waste in the system. Attempts to further flush this piping would result in increased probability of releases to the environment through possible leaks at bad welds (the reason these pipes were abandoned in the first place), as well as significant radiation exposure to the workers

The few process vessels and lines that have been isolated and abandoned in place will be left as is. This equipment was decontaminated and emptied prior to abandonment. These flushes were not formally sampled for RCRA hazardous material, but they were equivalent to the flushes used to clean the other portions of the system. These vessels and lines constitute a small fraction of the total system volume. The risks associated with reconnecting the vessels for additional flushing far outweigh the benefits of possibly removing a very small quantity of RCRA hazardous material.

The removal of one abandoned pipe section, 4" LD-1030C, was chosen for evaluation. This pipe segment is located in the WT area of CPP-601. An ALARA (as low as reasonably achievable) review was conducted and the amount of waste that would be generated was estimated. The ALARA review takes into consideration the type of work to be performed, the number of workers required to perform the labor, the hours necessary to complete the work, and the radiation field in the area where the work is to be performed.

In this case, there is the added industrial risk of being in a confined space. The waste trench is a tunnel 200 ft long, with only one access hatch in the ceiling in one end. There is no ventilation or lighting. Before work can begin to remove the pipe, access to the trench must be provided (the height of the trench floor to the ceiling is 20 ft), a ventilation system must be set

up, and lighting must be provided. In order to remove the abandoned pipe from the waste trench, it will have to be cut in 3 ft sections to be able to get it through the access hatch. A tent must be built to cover the area where workers are cutting the pipe as a prevention measure for potential spread of radiological contamination. The abandoned pipe is located in close quarters between two other active pipes. Before work can begin to cut the abandoned pipe, it would have to be dismantled from its floor supports and lifted above the two active pipes. The total man-hours required to accomplish trench access, ready the work area, and cutting and removing pipe has been estimated at 200 hrs. A work crew generally consists of two crafts (carpenter, welder, etc.) personnel and one radiological control technician (RCT). By multiplying the total man-hours by the radiation field in the area (also known as the general body field), the dose estimate to workers can be figured. The general body field for the waste trench is 30 millirem per hour (mrem/hr). The total man-hours multiplied by the general body field equals 6 ManRem. It is easy to see that removal of over 200 vessels and thousands of feet of pipe would result in unacceptably high radiation exposure.

### 4.2.4 Asbestos, Lead, PCB, and Mercury

Any asbestos, lead, PCB, or mercury containing equipment located below the level of the facility cap will be left in place. The structure above the facility cap will be collapsed to cap level. If possible, materials containing the above contaminants will be relocated in such a way that they will be incorporated in the grout fill beneath the cap. This will protect the environment while minimizing risks to the workers.

## Table 4-1
## Completed Vessel Flushes for RCRA Constituents

***CPP-601 Vessel Flushes***

| Procedure # | Coverage | Date | Sample Log # | Volume/Flush |
|---|---|---|---|---|
| SP-16-93 | G-Cell | 2-3/93 | NA | 2500L x 4 |
| PSM-33-93 | H-Cell | 3/93 | NA | 4200L x 4 |
| SP-99-93 | F-Cell | 5/93 | NA | 3400L x 4 |
| PSM-105-93 | E-Cell (includes G-101/151) | 5-6/93 | NA | 3500L x 4 |
| PSM-18-94 | FCE flush (selected E,F,G,H vessels) | 2/94 | 94-02057 (G-116) | 1800L x 4 |
| PSM-95-94 | Hexone extraction (O,P,Q,U,W,Y-Cells) | 7/94 | 94-07168 (U-101) | 4850L x 4 |
| PSM-231-94 with SOP 4.2.23.4 | L,M, & N-Cells | 12/94 | 94-12274 94-12275 (L-101) | Unknown |
| PSM-240-94 | J-Cell (includes S-116 system) | 1/95 | 95-01185 95-01186 (L-101) | 600L x 4 |
| SOP 4.2.23.4 | L & C-Cell | 3/95 | 95-03303 (C-101) | Unknown |
| PSM-78-95 | T-Cell (drum out hexone, water rinse) | 5/95 | 95-05295 95-05305 95-05306 (W-129) | Unknown |
| SOP 4.2.24.4 | Z-Cell/denitrator | | NA | Unknown |
| TP-32-97 | Z-Cell/denitrator | 5/97 | 97-05081 97-05082 (LC-163) | Unknown |

***CPP-640 Vessel Flushes***

| Procedure # | Coverage | Date | Sample Log # | Volume/Flush |
|---|---|---|---|---|
| PSM-61-95 | Cell 5-Electrolytic | 11/95 | 95-11137 (L-101) | 600L x 4 |
| PSM-28-96 | Cell 2- Rover Wet | 4/96 | 96-04171 (L-101) | 1000L x 4 |

***CPP-666 Vessel Flushes***

| Procedure # | Coverage | Date | Sample Log # | Volume/Flush |
|---|---|---|---|---|
| SP-111-93 | FDP Cell | 8/93 | 93-080919 | Unknown |

***CPP-601 Exterior Flushes***

| Procedure # | Coverage | Date | Sample Log # | Volume/Flush |
|---|---|---|---|---|
| PSM-42-95 | W & Y-Cells | 4/95 | NA | Used hose |
| PSM-63-95 | O-Cell | 5/95 | NA | Used hose |

All cells (except T-Cell, service corridor, and vent tunnels) were flushed externally with water and checked with a blacklight (UV) for traces of uranium. Flush water was jetted from the sumps to PEW. No samples were taken.

**Table 4-1 (con't)**
**Completed Vessel Flushes for RCRA Constituents**

| Vessel | Date Flushed | Chemical | Sample | Procedure |
|---|---|---|---|---|
| PM-100-●1 | | Nitric Acid Gadolinium | | Not done yet |
| PM-101-0 | 11/19/94 | Nitric Acid | Lab pH: 4.97, 4.88 | PSM 207-94 |
| PM-102-0 | 11/19/94 | Nitric Acid | Lab pH:3.4 pH strip: 6 | PSM 207-94 |
| PM-104-0 | 01/17/95 | Mercuric Nitrate | Lab analysis for Hg: 3.26 ug/ml, pH strip 5 | PSM 8-95* |
| PM-105-0 | 01/17/95 | Mercuric Nitrate | Lab analysis for Hg: 3.26 ug/ml, pH strip 5 | PSM 8-95* |
| PM-107-0 | 8/2895 | Scrub (IBS) | pH strip: 6 | PSM 102-95 |
| PM-108 PM-108-1/-2 | 07/20/94 | Scrub (IIIAS) | pH strip, ~6 | |
| PM-108-0 | 08/21/94 | Nitric Acid | Lab pH: 4.32 | PSM 153-94 |
| PM-109-0 PM-109-2 | 09/28/95 | AMSCO/EXXOL (IDS) | Lab analysis for flash point: no flash | PSM 126-95 |
| PM-110 | 12/29/94 | Nitric Acid | pH strip: 5 | PSM 226-94 |
| PM-110-0 PM-110-2 | 09/28/95 | TBP/N-Dodecane | Lab analysis for flash point: no flash | PSM 126-95 |
| PM-111 | 12/29/94 | Nitric Acid | pH strip: 6 | PSM 226-94 |
| PM-111-0 | 06/13/94 | Sodium Carbonate (IISW) | Lab analysis for carbonate: <.0045 M | PSM 100-94 |
| PM-112 | 07/03/95 | Nitric Acid | pH strip: 5.5 | PSM 83-95 |
| PM-112-0 PM-112-2 | 08/21/94 | Nitric Acid (ISW) | Lab pH: 2.36 | PSM 153-94 |
| PM-113 | 03/05/98 | Ammonium Hydroxide | pH strip: between 5 and 9 | TPR 23-98 |
| PM-113-0 F-PM-113-2 | 06/13/94 | Sodium Carbonate (IISW) | Lab analysis for carbonate: <.0045 M | PSM 100-94 |
| PM-114-0 | *Procedure written but not approved and performed* | Sodium Hydroxide | | Not done yet |
| PM-115-0 PM-115-2 | 08/21/94 | Nitric Acid (IIISW) | Lab pH: 3.62 | PSM 153-94 |
| PM-116-0 | 08/28/95 | Scrub (IIIAS) | pH strip: 6 | PSM 102-95 |
| PM-117 F-PM-118 | 12/20/96 | Boric Acid | pH strip: ~6 | PSS 191-96 |
| PM-123 | *Procedure written but not approved and performed* | Aluminum Nitrate | | Not done yet |
| PM-124 F-PM-125 | 11/24/94 | Scrub (IIAS) | pH strip: 6 | PSM 218-94 |

* *additional flush and sample needed for mercury*

**Table 4-1 (con't)**
**Completed Vessel Flushes for RCRA Constituents**

| Vessel | Date Flushed | Chemical | Sample | Procedure |
|---|---|---|---|---|
| PM-126<br>F-PM-126-1/2 | 07/20/94 | Scrub (IIAS) | pH strip: 6 | |
| PM-127<br>F-PM-128 | 11/24/94 | Scrub (IIIAS) | pH strip: 6 | PSM 218-94 |
| PM-129 | 08/28/95 | Scrub (IIAS) | pH strip: 6.5 | PSM 102-95 |
| PM-130 | 04/19/95 | Nitric Acid | pH strip: 6 | PSM 69-95 |
| PM-131 | *Procedure written but not approved and performed* | Sodium Hydroxide | | Not done yet |
| PM-133 | 07/03/95 | Scrub (IIIAS) | pH strip: 5.5 | PSM 83-95 |
| PM-135-0 | 07/24/94 | Nitric Acid (I/IIISW) | Lab pH: 5.27, 5.19 | PSM 141-94 |
| PM-164 | | Chromic Acid | | Not done yet |
| PM-170 | 06/17/96 | Nitric Acid | pH strip: 5 | PSS 89-96 |
| PM-175 | *Drained but not flushed* | Chromic Acid | Gamma scan: no nuclides TCLP metals: see work package | PSM 284-93<br>Not done yet |
| PM-180 | *Drained but not flushed* | Hydrofluoric Acid Boric Acid | | Not done yet |
| PM-186 | | Chromic Acid | | Not done yet |
| PM-188 | *Drained but not flushed* | Hydrofluoric Acid Boric Acid | | Not done yet |
| PM-194 | 07/25/96 | Boric Acid Gadolinium Oxide | pH strip: 6 | PSS 107-96 |